OBSERVATIONS ON THE HABITS OF TWO SPIDER MIMICS OF THE RED ANT, *OECOPHYLLA SMARAGDINA* (FABR.)[1]

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(*With five text figures*)

CONTENTS

INTRODUCTION

Myrmarachne plataleoides Cambr. and *Amyciaea forticeps* (Cambr.) are two well-known spiders which mimic the Indian Red Ant, *Oecophylla smaragdina* (Fabr.). These spiders belong to two distinct families and it is interesting to see how each with its particular family characteristics has effected this simulation of the same model.

1. HABITS OF THE MODEL AND THE MIMICS

The Red Ant, *Oecophylla smaragdina*, that forms the model for both these mimics is a common ant occurring all over India. Its nests built of a number of leaves bound together with silk and guarded ferociously by the innumerable inhabitants are very familiar objects. Observations on the habits of these ants are recorded by Rothney (1890), Wroughton (1892) and Hingston (1923).

Wherever colonies of these ants exist, one can generally come across two mimicking spiders—an Attid spider, *Myrmarachne plataleoides* and a Thomisid spider, *Amyciaea forticeps*. Observations on the former are recorded by Cambridge (1869), Peckham (1892),

[1] Read before the Thirtyfirst Session of the Indian Science Congress Association, January 1944 (Delhi).

Narayan (1915), Hingston (1927) and Mathew (1931, 1934, 1940). Observations on *A. forticeps* are recorded by Cambridge (1873, 1901), Pocock (1909), Shelford (1902), Graveley (1915), Kunhikannan (1916), Hingston (1927) and Bhattacharya (1934).

Myrmarachne plataleoides is a perfect mimic of the red ant; so perfect is this mimicry that even experienced biologists may pass it by as an ant, in the field. There is a complete copying of the external form and coloration of the ant[1]. To this passive mimicry is added a close imitation of the general movements of the model. The front legs are long and directed forwards and, whether the animal is moving about or halting, these front legs are always kept in motion and very often held raised up. In this position, frequently, the leg is bent about its middle so as to simulate the 'scape' and the 'flagellum' of the ant's antenna.

During daytime these spiders may generally be found wandering on foliage not far from red ant colonies. To distinguish the spiders from the red ants as they move amongst them is rather difficult. Still, a few minutes' observation will show one that in details of behaviour the spider is quite un-antlike and thus can be distinguished. When one of these spiders is disturbed—the shadow of an observer is enough to do this—after 'looking' at the intruder for a moment, it tries to escape. If it is on a leaf it dodges to the under-side and keeps quiet. One who has disturbed a red ant colony will realise that this is what an ant would never do. If the spider is still pursued, it moves fast in an attempt to get away. Sometimes it drops on the ground and thus baffles the would-be captor; for, once among the underlying scrub and dead leaves with many red ants moving about, detection of the tiny spider is very difficult. Most often, however, when the spider lets itself down like this, it will have a silken cable attached to the leaf from which it dropped, so that it does not always reach the ground but hangs midway. The particular behaviour often depends on the extent of the disturbance. If it is slight, the spider merely hangs by the silken cable for a minute or two and then climbs back to the leaf; but if the disturbance is greater, the cable snaps, and the spider drops down amidst the rubbish below.

Specimens collected in the field show certain variations in colour and size. Adult individuals have been met with which are not larger than three-quarters the normal size, some even so small as only half the normal size. It is interesting that this wide range of variability in size was noticed mainly in the males. Observations on some young ones which I reared in artificial cages suggest that this depends to a great extent on food; regularly and well-fed individuals at the final moult attained to the normal size and those which were underfed developed into smaller individuals. In coloration too there is variation. Specimens which were in close proximity to the red ants had the normal reddish brown colour, whereas those collected away from ant colonies had a darker colour. My breeding experiments in this case have also given some suggestions as to the probable

[1] *vide* references cited above.

causes of this variability. I noticed that generally, when quite highly coloured individuals were confined in cages and fed on a diet of gnats and flies, they turned several shades darker, in two or three days. This suggests that the variation in colour may be, partly at least, due to diet.

Amyciaea forticeps is a Thomisid spider which, by an approximation in size and coloration to the *Oecophylla*, has attained a general likeness to this ant but lacks the part-to-part correspondence so striking in the Attid mimic. Attempts to show such a correspondence have been unsatisfactory and often conflicting (see Pocock and Hingston). It is an aggressive mimic and may be seen moving about in a characteristic way in 'rushes and pauses' with a peculiar trembling movement of the first two pairs of limbs near streams of red ants or their colonies (fig. 1). It is said that these spiders keep the first pair of legs stretched in front, simulating the ant's antennae as has already been noticed in *Myrmarachne*. My observations however do not confirm this. While watching a specimen of this species for some time, one might occasionally see it in such a posture but normally it is seen to move about in a series of rushes and pauses during which the first two pairs of limbs, which are longer than the other pairs, are raised up together and brandished in a convulsive manner (figs. 2 A, 2 B and 2 C). As these two pairs

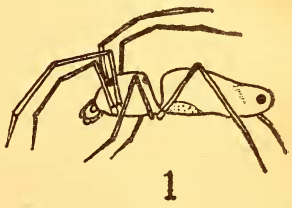

FIG. 1—*Amyciaea forticeps* in ordinary movement.

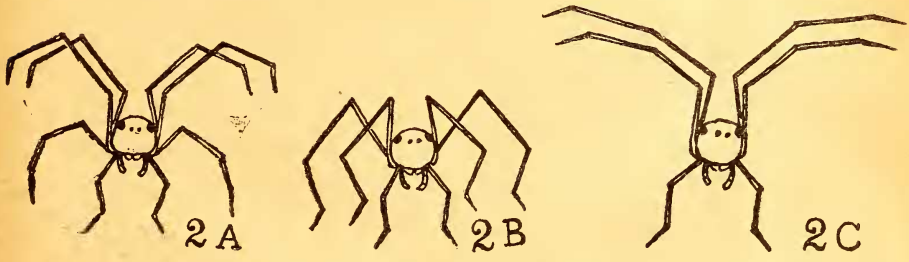

FIG. 2—*Amyciaea forticeps*. Postures presented as the animal moves along, due to the peculiar movement of the first two pairs of limbs.
2 *A*—First two pairs of limbs raised up so as to form a pair of double arches.
2 *B*—These two pairs of legs brought down together for a moment.
2 *C*—Immediately after, they are jerked upwards.

of legs are held up over the head bent in a characteristic manner forming two double arches, they suggest little resemblance to the antennae of the ants.

When among the ants, it is interesting to notice the extremely cautious movements of these spiders, always avoiding the main lines of the ants. Confronting one of the ants, the spider immediately dodges to the opposite side of the leaf moving dexterously sideways in true Thomisid fashion, or it may drop on its silk line 'safety cable'. Though it shuns the ant in the open foliage it is a regular hunter of these ants, stalking and feeding on them. It waits watching for

an unwary stray ant and, when it sees one, cautiously approaches it and finally makes an unerring spring.

Hingston (1927) remarks that these spiders make silken retreats from which they emerge to capture the ants. I have failed to see any retreats made by these spiders; they do not make any. They hunt their prey in the open, lurking in the paths of the ants.

In February 1930, I kept a few of these spiders and two red ants in a glass box. After wandering about for some time one of the spiders was seen stalking an ant. Facing the ant the spider retreated a little and waited for its chance. As it thus waited the body was balanced on the 3rd and 4th pairs of legs, the 3rd pair directed forwards and the 4th pair backwards. The two pairs of legs in front are held up together and gracefully bent at the joints forming a pair of double arches and are kept constantly quivering in a characteristic way. This quivering movement of the limbs together with the two conspicuous black spots on the abdomen suggesting a pair of eyes gives the picture of a struggling ant. Probably this serves as a lure to the ant. Whereas an ant under normal conditions may not mistake a spider as it moves along for a member of its own species, it is quite possible that a small ant-like body with the legs all quivering may suggest an ant in trouble. The ant immediately took up the usual alarm attitude, paused, raised the body on the legs, held the antennae up and bent the abdomen sharply over the thorax. This was the spider's chance. It quickly moved to a side and by a sudden unerring spring jumped on to the back of the ant and thrust its chelicerae into the ant's head (fig. 3). Immediately the ant bent its body double and was motionless. The spider left it for a moment but soon returned and began sucking it. Meanwhile the other ant which was in the cage became highly alarmed and, moving hurriedly with mandibles held wide open, came across the spider quietly enjoying its meal; in a moment the spider was struggling between its mandibles, helpless.

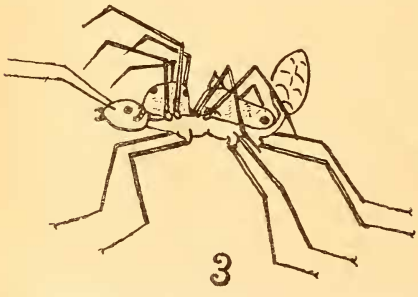

Fig 3—*Amyciaea forticeps* springing on an ant.

A similar observation regarding the hunting habits of *Amyciaea* has been made by Mrs. Drake as recorded by Graveley (1915). Though this appears to be the method of capture as observed in cages, my observations in the field show a different behaviour. One evening while searching for spiders near an *Oecophylla* colony, I came across a stout *Amyciaea* stalking a stray ant. It moved in its characteristic manner, took up the 'luring posture', and then made the spring; the ant struggled, and the next moment I saw the hunter and the hunted tumbling down together from the twig. The spider never lost its firm hold on the prey but as it rolled down, it glued to the twig its 'safety cable' so that, instead of falling down on the rubbish below where the ant probably could make a good struggle, it hung down from the twig on the slender cable in mid air with the ant struggling

between its chelicerae (fig. 4). Here the spider was 'at home' and the ant helpless. After hanging in this position for a while the spider began sucking its prey. Sometime later it climbed back to the twig carrying the prey along with it and there continued to suck it at different parts.

Since then I have observed on several occasions spiders of this species enjoying their repast hanging in mid air on their threads from the open foliage. This is certainly safer since red ants move about in the vicinity and, if one of them surprises the spider, the latter would have no way of escape as was noticed previously in one of my observation cages.

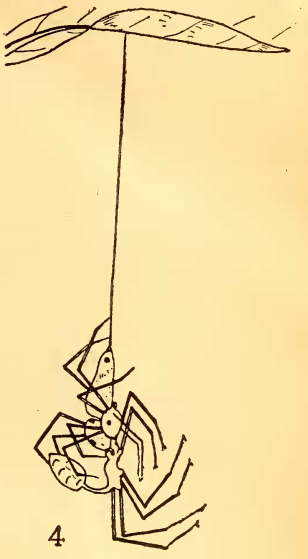

FIG. 4—*Amyciaea forticeps* hanging from a silken thread and sucking a captured ant.

2. The Relations of the Model and the Mimics

Amyciaea feeds on its models and so its close association with ant colonies is easy to understand. But it is difficult to see why the formidable red ants wink at the intrusion into their midst of these dangerous assassins, especially when we realise how uncourteous these ants generally are to intruders, and how fiercely and tenaciously they defend the colony and the nest from outside interference. It is surprising, similarly, to note the same apparent indifference shown by these ants towards the Attid mimic *M. plataleoides* which also enjoys the closest proximity to these insects. It is commonly suggested that by their ant-likeness they are mistaken by the ants for members of their own community and that thus they are tolerated. Regarding *A. forticeps* it is claimed that in this false garb it can get into ant colonies unrecognised and thus have plenty of unsuspecting prey on which it can feed with impunity. This interpretation cannot, however, be held in the light of what we know of insect vision on the one hand and of the discriminating instincts of the ants on the other. We have no reason to imagine that the ants are deceived by the false garb of the spiders so as to mistake them for other ants. The behaviour of the ant when it faces one of these spiders is ample evidence that it is not in any way deceived as to the real nature of the intruder.

(*a*) *Certain observations on the discriminating powers of Oecophylla*

Two individuals from a distant colony of red ants were introduced on a shrub where there was a thriving colony of these ants kept under observation. These moved about on the leaves. One of them soon came across one of the smaller type of workers of the colony. The latter immediately 'recognised' the stranger and, without waiting for any help or running away scared by a larger opponent, fearlessly attacked

it. It gripped one of the legs of the intruder with its mandibles and pulled it hard but the other struggled and bending its body caught the enemy by the neck and severed the head from its body. The carcase of the defender rolled down the leaf, but its head never lost its firm grip. Meanwhile some half a dozen members of the colony had come on the scene and gripped the intruder at different places. Two held the antennae and pulled them tightly in opposite directions. Others caught hold of the legs and pulled them apart, while others got on the body and began to bite and tear viciously.

While they were so uncourteous towards members of strange colonies, they appeared to be very considerate towards individuals of their own colony which were kept away from them for some time. On their being restored they were received with apparent cordiality and were not attacked. The *Oecophylla's* sense of distinction goes a step further. One family seems to establish more than one colony —sometimes quite a number of colonies, grouped close together on the same or adjacent branches. Individuals of these different colonies, but all belonging to the same family, seem to recognise each other perfectly well for, when they meet, there is no show of hostility but they seem to get on in the most friendly manner. Into a nest which was under observation I introduced a worker from one of the adjacent colonies whose proximity to this nest convinced me that they must form one family. It was not attacked.

These observations show that: (1) *Oecophylla* can readily recognise members of its own colony (2) It distinguishes members of friendly and allied colonies with little difficulty and accords to them the proper cordial treatment (3) It recognises members of other colonies and is quite inhospitable to them.

(*b*) *Do the ants mistake these spiders for other ants?*

Possessing such instincts of discrimination as observed above, it is highly improbable that the ants would be deceived by the false garb of these spiders with its many imperfections. My observations convince me that the *Oecophylla* recognise these spiders as strangers and are alarmed. I have often closely watched specimens of *M. plataleoides* as they move about on plants with streams of red ants. The spider is very careful to avoid the ants, and if it comes across one, it immediately beats a hasty retreat and escapes. The ant recognising it (or recognising that something is amiss) assumes its alarm attitude which gives the spider time to escape. Should the ant pursue, the spider quickens its pace, dodges under a leaf, or as a last resort lets itself down by a thread and hangs suspended in air where the ant cannot pursue it. The ant, losing its quarry, abandons the chase. If somehow this method of escape is rendered impossible or prevented, the ant pounces upon it in the most relentless manner and carries it triumphantly to the nest. This applies equally truly to *Amyciaea*. Coming across the foraging ants, this spider dodges and escapes or drops on a silk thread as *Myrmarachne* does. Only stray ants are 'lured' in the characteristic manner described above and secured as prey. It never behaves as if it felt safe near the ants but is ever on the alert. A moment's neglect or ease may find it being crushed

between the mandibles of the ant! The safety of these spiders then from being attacked by the red ants amongst whom they live depends, not so much on their deceptive garb though commonly thought to be so, as on their cleverness and quickness in perception and movements. Their sight and nimble movements in any direction as may be necessary and their possession of the 'safety cable' ready for use at any time, alone make them safe in the midst of these vicious ants. What then, it might be asked, about the protective value of ant mimicry? By looking like ants and haunting their vicinity, these spiders do secure comparative safety from their usual enemies, as has been pointed out by me in a previous paper (1934). But we are not to think that the false garb in any way deceives the ants themselves.

(c) *Does Myrmarachne feed on its models?*

Does *Myrmarachne* feed on its models as *Amyciaea* does? The few observations recorded that it does were quite likely made as a result of confusion between these two mimics. My observations extending over many years and made under diverse conditions show that *M. plataleoides* does not feed on the red ants. I have also made some tests with other Attid mimics and their models; I have never seen any Attid mimic attacking its model. This is quite a contrast to the Clubionid and Thomisid mimics which regularly hunt and prey on their models.

Though *Myrmarachne* does not feed on the red ants, it still keeps persistently close to the ant neighbourhoods. This may suggest that there is some biological interrelation between these animals. Many times I have seen these spiders getting as close as possible to the nest of the ants; and occasionally seen mature or immature individuals waiting in their 'retreats' on the underside of a leaf which was just an inch or two below the nests of these ants. But I have never seen them getting any further.

While camping at Karupanthode, Travancore Reserve Forests, in December 1929, I came across a red ant nest which was deserted by the occupants. On opening it I found a female *M. plataleoides* inside. Sometime later in Parur, North Travancore, I came across a male and a female *M. plataleoides* in a 'mating nest' within a deserted nest of *Oecophylla*. Probably the spiders might have got in after the nests were deserted by the ants. But, on another occasion in the summer of 1931 at Parur I found a female spider in a nest of *Oecophylla* still tenanted by a few ants. I have ascertained definitely that these spiders do not live in ant nests as certain other spider mimics do. The above observations therefore merely suggest that under certain conditions they may enter ant nests.

It seemed that the larvae and pupae of the ants might be the attraction for these spiders. To see if these would be taken and relished as food, I put a few ant pupae in a cage where there were a few spiders. Since they ordinarily take only moving prey I was not expecting any positive results. But in a few minutes, when I returned to the cage, I was quite surprised to see the spiders each with a pupa in its jaws and busy sucking it!

Later, a red ant's nest from which most of the ants were driven off leaving only a few larvae and pupae with a few smaller workers who persisted in remaining with the pupae, was gently dropped into one of the cages containing a few spiders. After a few minutes the spiders approached the nest with great caution. They moved carefully halting at every step. Getting on to the leaf on which the nest was, they moved about on its outer side. One casually got on the other side; it must have seen the ants guarding the pupae, for it immediately dodged to the opposite side of the leaf. As it was thus approaching the pupae it showed evident signs of caution or fear; for, at the slightest movement of the ants or even of the cage, it would suddenly run back. After some time, however, I saw each of these spiders holding a pupa in its jaws! How they did it I was not able to observe.

Once while collecting egg cocoons of these spiders I came across one cocoon near which was a nest of the small brown ants. In the cocoon the eggs had hatched and the spiderlings had completed their second moult within the cocoon and had become quite ant-like; their size and dark coloration made them appear very similar to the brown ants which were moving about on the leaf. This relation appeared quite interesting. The nest was taken to the laboratory and put in a glass cage. In doing this I evidently disturbed the young spiders as well as the ants; for, they became restless and leaving their nests began to wander about the glass cage. The disturbed ants according to their universal custom had each taken in its mandibles a larva or pupa and were wildly moving about for some time. Finally, they settled in a corner of the glass cage with their charges still in their jaws. Afterwards two of the spiderlings were seen moving to the new ant settlement; getting close to it they spun their retreats and settled close by. It seemed that these spiderlings too, like their parents, may be larva and pupa stealers, but these exploit, not *Oecophylla*, but the small brown ants which they mimic.

An attempt was made early in 1932 to see if a spiderling could be reared from its earliest stages on a diet exclusively of ant larvae and pupae. It was quite a success and it is specially noteworthy that the specimens continued to be healthy and vigorous through all the stages.

These studies show that quite possibly these spiders are larva and pupa stealers of their models. This may be only a step towards becoming actually aggressive; for, from the habit of feeding on larvae and pupae of the models to feeding on the models themselves is only a small step—yet, one accompanied by greater risks and therefore perhaps never taken.

3. Diurnal Habits of the Spiders

During daytime *M. plataleoides* wander about in search of prey and towards dusk they generally spin silken shelters or retreats in which they rest for the night. They have seldom been seen to go

back to their old retreats, being satisfied with making a fresh retreat for the night wherever they chance to be. When confined in small cages they have quite often been noted to use the old retreats if they are not badly torn. The females, with their cocoons and guarding the eggs, stray out only a short distance from their 'nests' and return soon to their charge.

My observations show that these spiders 'rest' in their retreats during the whole night and do not stir out after nightfall under normal conditions. Some of the observations and experiments which have convinced me that these spiders are not nocturnal were given in detail in a former paper (Mathew, 1931). The following observations may be noted:

1. In the field, towards dusk, these spiders can be seen making their retreats in which they remain all through the night.

2. When kept in observation cages they do the same.

3. At night, observing an individual in its retreat we note that it fails to observe the intruder's approach; in the daytime it would be almost impossible to approach them without being noticed.

4. At night when an individual is within its retreat, if a needle is taken to its front and waved to and fro, it is not perceived. Only when touched by the needle does it become aware of any disturbance. But even then it does not realise the real nature of the disturbance; it simply gets out of the retreat and runs about in a confused manner.

5. A specimen was kept in a cage and occasionally fed on tiny insects. One night after the spider had retreated into its nest, a small insect was introduced into the cage to see if the spider would attack it, which could be expected if it were nocturnal. But the next morning the insect was found alive and the spider still at rest. A few minutes later the spider got out of its retreat and soon afterwards caught the insect and sucked it.

The retreats made for the night are never so thick and well built as the moulting chambers. They often consist of only a canopy over the spider resting on a leaf; the canopy being narrower towards the ends, both of which are open. The spider can conveniently turn about within this retreat. As it rests under the canopy the forelegs are stretched out forwards and upwards, so as to be in contact with the front part of the canopy; the tarsi are bent downwards so as to stretch across the front opening. The last pair of legs are stretched backwards in a similar manner with the tibia in contact with the dome and the tarsi resting on the floor stretched across the posterior opening. Thus both the openings are guarded and at the slightest disturbance, whether on the dome or at any of the openings, the spider is on the alert. If the disturbance is from behind, it immediately turns around within the retreat and faces the intruder. If however the disturbance is sufficiently serious, the spider rushes out wildly and escapes.

Amyciaea too is diurnal. During the day it is active near the colonies of the red ants. During the night it rests. However, it does not make retreats as *M. plataleoides* does. On the other hand towards nightfall it spins irregular tangles of silken threads stretched between adjacent leaves or twigs and suspending itself

in the middle of this framework, it rests secure (fig. 5). The two front legs on either side are held together and stretched outwards at right angles to the length of the body in a straight line. The third pair of legs which is the smallest pair, each grips one of the filaments while the last pair is directed backwards holding on firmly to the strands behind. In such a position it can rest secure from the predacious red ants which may be moving in the vicinity.

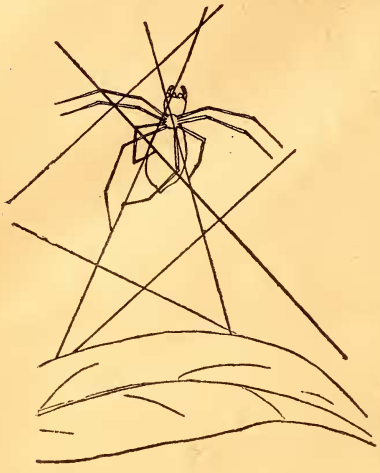

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Fig. 5—*Amyciaea forticeps*. Position of night repose.

4. Courtship and Mating

The courtship and mating habits of *M. plataleoides* have been described by me in a previous paper (Mathew, 1940). It was shown that pairing normally takes place in 'pairing nests', without any preliminary courtship.

Regarding the courting habits of *Amyciaea*, Bhattacharya (1934) has recorded certain observations. The following observations of mine may be added.

On June 4, 1930 I saw a stout female *Amyciaea* on a portia twig along which a stream of red ants was moving. On an adjoining leaf was a male, smaller and of a more slender build than the female. I secured them both in tubes and later put them together in a cage. Considering their aggressive nature I hesitated to put them together but there was no show of hostility; they moved about the cage in their characteristic way, in rushes and pauses, the anterior two pairs of legs being stretched out and flourished with a quivering movement during the pauses. This has been thought to have some special relation to courtship. It is referred to as a display of their graceful movement of legs in courtship. But I have shown above that they behave in this way in their ordinary movements. Soon they came near each other and then, without any preliminary 'courtship', the male made a sharp jump on to the back of the female as he would pounce upon his prey. He took up his position above her abdomen, facing in the same direction as she. This is unlike the positions taken up by male and female *M. plataleoides* in pairing, who face in opposite directions and both have their legs resting on the floor. Here, the male plants all his legs on the female's abdomen leaving her perfectly free to move about. While the male adjusted his position on the female's back, she remained quiet in a crouching attitude. Soon, however, the female resumed her normal posture and on the slightest disturbance, would move about carrying the male on her back. She was in fact quite free to move and continued to do so in the cage for about a quarter of an hour. The movements then gradually stopped and she became quiet. The male felt for the epigynum of the female with his palpus and the sperm transfer was

effected. They remained in this position for about half an hour, and for most of this time they were quiet except for an occasional quivering movement of the first two pairs of limbs. After copulation they separated and wandered apart.

Here we notice certain marked differences from the pairing habits of *M. plataleoides*. It is clear that in *Amyciaea* there is no preliminary courtship. Their 'recognition' or 'realisation' of each other seems to be instantaneous and, the moment the male has planted himself on the back of the female, the latter's feeding instinct is suppressed and she is ready to pair. Again, in *Amyciaea* pairing takes place in the open and not in any 'pairing nests'. *M. plataleoides* withdraws into specially constructed nests for pairing, and it was pointed out in that connection (Mathew 1940) that this was necessary, since they live in close proximity to the predacious red ants which might at any time surprise them. But in *Amyciaea*, which too lives in identical surroundings the necessity for retreating into a nest is dispensed with since the female during pairing is completely free to move about carrying the male on her back. If surprised by a forager ant, she can dodge under cover and escape.

5. Cocoons

Both these spiders make special cocoons in which they lay their eggs, and the 'mothers' remain guarding them long after the eggs have hatched out—till the spiderlings have become fit to leave the cocoons.

In *M. plataleoides* the cocoon is generally spun on the upper surface of a leaf though, during the rainy season cocoons have been seen on the underside of large leaves. On the surface of the leaf a small sheet of silk is first spun—this in confinement takes a long time. The eggs are laid usually in one group and arranged side by side in a single layer, in contact but not stuck to each other. Over this a fine silken felt sheet is made completely enclosing the eggs, its edges being firmly attached all round to the surface of the leaf. This layer is reinforced by another or sometimes two or more layers over it closely adherent to it. In many instances I have seen a second clutch of eggs added after the first layer of felt has been fully spun, so that this clutch of eggs lies between the first and second layers of felt. The second clutch when present contains a smaller number of eggs compared to the first; while the first clutch contains about 20 eggs, the second has only 5 or 6 eggs.

After the felt layer over the eggs has been completed, the spider takes up her position over it; above her, she spins a dome-like canopy enclosing herself and the cocoon with the eggs. This canopy is of the usual type with an opening at each end. Sometimes there is an irregular scattering of white fluffy silk on the wall of this dome recalling the 'stabilimenta' of some of the web-spinning spiders. Inside this retreat she remains till the eggs are hatched and the spiderlings ready to leave the cocoon. Only rarely she leaves the cocoon, probably in search of food. The emaciated condition of most of the spiders guarding the cocoons shows that they do not venture outside very frequently, even for feeding. When disturbed they

appear very unwilling to desert their precious charge. During the monsoons I have come across a few nests with eggs but soaked in water. The mothers were found dead in their 'on guard' positions. Perhaps the sudden rains wetting the whole nest made their escape impossible.

Generally the cocoons are seen singly, but occasionally one comes across numbers of these aggregated on a single leaf. This tendency to aggregate during egg laying has never been seen in *Amyciaea*.

Amyciaea too makes a cocoon which the female guards with great tenacity. The cocoon is generally made on the concave inner surface of a leaf the edges of which are drawn together by two strong bands of silk. On the leaf a silk sheet is spun over which the eggs are laid. The eggs are not arranged in a flat row as in *M. plataleoides* but all stuck together in a round ball. In *M. plataleoides* they are separate, not stuck to one another. Over the mass of eggs a thick felt is woven the edges of which are fused to the surface of the leaf all round. Over this felt the female takes up her position in true Thomisid style. There is no canopy over her as was noticed in *M. plataleoides*.

6. Life-History

The life-history of *M. plataleoides* has been described by me in a previous paper (Mathew, 1934). It was shown that the young too are ant-like and mimic different species of ants according to their size and coloration at their different stages, and this interesting form of mimicry was termed '*Transformational mimicry*'. It was seen that the young too share the advantages of mimicry; thus solving an old problem of the protective methods of the young of those spiders which are protected by mimicry as adults. This phenomenon introduces certain complications for the field naturalist. Collecting ant mimics he often comes across many spiders mimicking common ants. While it would be interesting to note models and mimics, their habits and behaviour, since many of them would be immature, their identification would be impossible unless the life-history of each species has been fully determined. A spider which when adult mimics a certain ant is observed in its early stages to mimic other ants out of necessity, as shown in the paper referred to (Mathew, 1934). Another fact to be noted is that the ants which form the models for the immature forms of certain spiders have certain other spiders mimicking them in their adult stages. Thus the small biting ant *Solenopsis* which is mimicked by *M. plataleoides* in one of its early stages, has a small species (very near *M. spissus*) mimicking it as adults. The small black ant *Prenolepis* is mimicked by an early stage of *M. plataleoides* as well as early stages of certain black mimics like *M. manducator* and *M. ramunni*.

The form of the cephalothorax which is an important basis for specific distinction attains the characteristic shape only when adult or in the later stages. The cephalothorax of an immature form is different from that of the adult and often resembles that of some other species. The falces, sternum and the epigynum which are such distinctive features of most species attain the typical form only in the adult stages.

In the development of *Amyciaea* no such transformational mimicry is seen. The young ones are of the typical crab-spider form with light green coloration without any ant-likeness. The two pairs of front legs which are the longest as in the adult are marked with certain reddish bands and these legs are held up and nervously brandished like the performance of the adult. The ant-likeness is assumed only in the later stages. As these spiders are of a more shy and retiring nature like the typical Thomisidae, contrasting with Attidae which more boldly expose themselves in the open, special protective methods in the earlier stages may not be so essential.

7. Concluding Remarks

It was shown that the mimicry seen in *M. plataleoides* is most perfect when the spider is in movement in the company of ants. With reference to protective coloration Beddard (1892) has pointed out, and it is now well recognised, that it is not merely the coloration and pattern that contributes to safety but also immobility. A recent writer, (Cott, 1940) expresses this as follows: 'Compared with stillness cryptic coloration is relatively unimportant; but combined with stillness it is all important'. An individual however protectively coloured, if it actively moves about, runs the risk of being conspicuous. But in a true mimic of the type of this spider—which copies not an immobile object but an active organism—we find that the perfection of the mimicry depends not so much on the external appearance as on the imitation of movements. Thus in these two types of resemblances, one copying a passive object and the other an active one, safety seems to depend primarily on the passivity of the former and on the activity of the latter.

The purpose of ant mimicry by spiders is believed to be either protective or aggressive. The value of ant mimicry as a protective device has been discussed in a previous paper (Mathew, 1934) where I have shown that the objections which are ordinarily brought forward against this have arisen as a result of the faulty way in which this function is usually explained.

Amyciaea is a mimic of a different type. Its mimicry is termed aggressive since it feeds on the models, and the protective value of its mimicry is not stressed. It has been shown above that the ants never mistake these for other ants and that both these mimicking spiders enjoy the proximity of ants not by virtue of any simulating powers but only by their shy nature and possession of the safety cable. The role of mimicry here as an aid to aggression has been explained. It is not an actively moving ant that is mimicked but a struggling or dying ant, thus serving as a 'lure' for would-be prey. This explains why the mimicry appears far from perfect and why there is no imitation here of the normal gait of the ant. In addition the mimicry may also have a protective value. Though these spiders are aggressive towards their models, it does not mean that they are immune from the attacks of their own numerous enemies.

For protection through ant-mimicry it is essential that the mimics should be amongst, or at any rate, close to the models. Field observations show that they are actually seen in the proximity of the

red ants. What can be the incentive that keeps these mimics in their proper surroundings?

Amyciaea feeds on the red ants and so its seeking proximity to the latter is easy to understand. It has been shown above that *M. plataleoides* too has an attraction since it steals and preys on the larvae and pupae of the ants. The young ones of this species which mimic the *Prenolepis* ants have been seen to steal the larvae and pupae of these ants and, evidently for this purpose, to keep their company. In a previous paper (Mathew, 1935) I have shown ants mimicking bugs feeding on plants which are also frequented by the models for certain exudations of these plants; model and mimic frequent the same plant for food and thus the mimic gets the requisite surroundings.

Beddard (1892) in considering a similar question says: 'It is not generally believed that insects and other animals that are protectively coloured deliberately select for a temporary resting place a situation—whether it be a trunk or a leaf—that harmonises with their own colour. The theory is that their colours have been modified in accordance with their usual environment, those that habitually settle among trees being green and so forth. It has, however, been stated that a small black moth (*Physis carbonariella*) is constantly met with in patches of underwood that have been burnt; its dusky hues approximate with the colour of charred wood.'

The theory that colours have been modified in accordance with their usual environments, while it might explain how a particular pattern has been arrived at in the course of generations, does not explain how a particular individual having a particular pattern gets into the proper environment. This difficulty would not arise in the case of fixed organisms or organisms which move only to a small extent; but in an animal with active habits like these spiders the question of being in the proper surroundings is very important.

8. Summary

Observations on two ant-mimicking spiders, the Attid *Myrmarachne plataleoides* and the Thomisid *Amyciaea forticeps*, mimicking the common red ant *Oecophylla smaragdina*, are recorded. *M. plataleiodes* mimics not only the external form but also the movements of the model. *Amyciaea* is alleged to raise the first pair of legs to simulate the antennae of the ants but this is denied. It keeps both the first and second pairs of legs raised, bent and quivering in a characteristic manner serving to 'lure' the ants. The usual claim that by their mimicry these spiders are mistaken by the ants for other ants and thus they procure plenty of unsuspecting prey, cannot be accepted in view of the discriminating powers of *Oecophylla* experimentally shown.

Both these spiders are diurnal and their night retreats are described. *Amyciaea* 'sleeps' suspended on a sling made for the night. Mating of *Amyciaea* is not preceded by any courtship as is sometimes suggested—the nervous movements noted when two individuals come together being observed also as they ordinarily move about. The young of *Amyciaea* do not mimic ants, contrasting in this respect

with *M. plataleoides* whose young mimic small species of ants exhibiting the phenomenon of *Transformational Mimicry.*

The purpose of ant mimicry in both these spiders is protective—from the usual enemies of spiders. In *Amyciaea* it is, in addition, *aggressive*—helping to lure and capture stray ants. For protection through mimicry, it is essential that the mimic be amongst or near the models. How this is brought about in the case of these spiders is discussed.

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